The Engineering News.

JANUARY, 1875.

Our Programme.

What word in our language is more expressive of practical science, what one more significant of public improvements, than ENGINEERING? Are not the names of all the great Engineers of our own and other lands, associated in our minds with men whose favorite studies were in the domain of science, and who, having mastered the principles thereof, were able to apply them to the use and benefit of their fellow-men?

It is with reason, therefore, that we have chosen the subsidiary title to our journal, under which we can not only discuss strictly professional subjects, but also convey to the general public in a popular manner an accurate knowledge of the numerous applications of scientific principles, that are daily being made in their presence, in the shape of the many improvements of modern civilization.

When we look over the list of the works upon the construction of which the engineer is engaged—Roads, Railroads, Canals, River and Harbor Improvements, Docks, Breakwaters, Bridges, Tunnels, Telegraphs, the Sanitary Improvements of cities and towns, and the Drainage and Irrigation of large tracts of land, besides many others, and consider the amount and variety of knowledge necessary to meet and overcome the difficulties which frequently and unexpectedly arise in the progress of either of them, we may form an idea of how much the simple word ENGINEERING comprehends and how closely it is allied with the interests and welfare of all classes of community.

Now one of the marked features of the present times is the growing demand for scientific information So clearly apparent is this that many of the great daily newspapers and several of the principal magazines devote considerable space to the latest scientific news. This interest has been largely awakened by the discussions that have recently arisen about the so-called, but wrongly supposed, conflict between science and religion, and has resulted in a desire among thinking people to investigate for themselves.

"THE ENGINEERING NEWS" will be published as a Journal of Practical Science and Public Improvements." It will be devoted, even more than in the past, to the interests of Engineers, Surveyors and Architects, while at the same time it is our purpose to reach other large classes of readers, such as railway officers and employes, Capitalists, Contractors, Manufacturers, Real Estate owners and dealers, and Hardware, Iron and Coal Merchants,—classes from which come the principal employers of engineering talent, and by which all great public and private enterprises are inaugurated and carried forward.

To accomplish our purpose we propose to popularize, as far as advisable, the contents of our journal; to bring together the many valuable contributions to Engineering literature that are now scattered through the numerous scientific publications of this country and Europe; to collate formulae adapted to the practical needs of the profession; obtain by contribution or personal solicitation and examination correct descriptions of the principal engineering works of America, and report as far as obtainable their progress from time to time; report the proceedings of scientific societies; the publication of new scientific books, and all other news that we may consider of interest to our readers.

Our efforts during the past nine months have succeeded in creating an interest among engineers and surveyors; we hope, therefore, to be able during the present year to secure a larger number of orignal contributions than we have in the past. We again earnestly solicit the co-operation of the profession to to make our journal a source of mutual benefit, and a medium of intercommunication between themselves. Give it a hearty support by your subscriptions, by writing for its columns, and by your recommendation and encouragement. We have placed the subscription price at the present low figure to induce an extensive circulation and secure advertising patronage; we have increased the size and quality of the paper, and we will guarantee future improvements to keep pace with our encouragement.

May we not therefore rely upon the generous support of American Engineers, Architects, and Surveyors, to sustain our enterprise and place "THE ENGINEERING NEWS" in the front rank of scientific professional journals.

The Manner of carrying on the United States Survey of the great lakes.

The following paper, read some time ago before the Civil Engineers' Club of the Northwest, by F. U. Farquhar, Captain U. S. Engineers, is of so much value to Engineers and Surveyors, besides being of interest to the general public, that we propose to give it a more extended notice than it has heretofore had through the published papers of the society.

The United States surveyof the lakes was commenced in 1839 under the direction of the Corps of Topographical Engineers. Previous to this time a survey had been made under the British Government by Lieut Bayfield, R. N.

The surveys made by Lieut. Bayfield are wonderful, when we consider the means used and the short time he expended in making them. Longitude, latitude, and shore line were determined by use of chronometers and sextants. His maps are practically correct, few shoals or other dangers lying on the track of commerce having escaped his observations.

It was not until 1849, however, that the United States survey of the lakes took the organization it now has. Between 1841 and 1849 the survey had been carried on at the localities where information was most needed.

In 1849 a trigonometrical survey of the lakes was commenced, and has been carried on to the present time. The surveys of lake Superior, Huron, St. Clair, and Erie, and the connecting rivers are completed. The surveys of Lakes Michigan and Ontario will be completed during the next two years.

The manner of making the surveys will be described under the following heads:

1. Minute hydrography and topography.
2. Off-shore hydrography.
3. Astronomy.
4. Triangulation primary.
5. Magnetic observations.
6. Gauging the outflows at foot of each lake.
7. Meteorological observations.
8. The projection of the surveys, or chart making.

I.—MINUTE HYDROGRAPHY AND TOPOGRAPHY.

Under this head is comprised the work of determining the depth of water from the shore line to the six-fathom curve, or at least half a mile from shore, and to a depth of water sufficient for the steamers determining the off-shore hydrography to run into, so that the latter work may over-lap the former. This party also makes a topographical survey of the coast and for at least one mile inland, and determines accurately the position of any prominent features of the land as seen from the deck of a vessel. The parties organized for this work consist of one officer in charge, one assistant, one recorder, one foreman, two leadsmen, two chainmen, fourteen oarsmen, one cook, one waiter and one steward.

The party is supplied with at least two theodolites, (arranged for stadia measurements) one sextant, one compass, chains, pins, etc., etc., two six-oar boats, tents, and all appliances for camping out and subsisting.

A certain amount of work having been assigned to a party, they generally commence it as soon as the season will permit.

The first camp is generally pitched about five or six miles in the direction of the season's work, from its commencement, and is moved from time to time as the work progresses. As far as possible the moving from camp to camp is done by means of one of the lake survey steamers. The first work after pitching and arranging the camp is to locate and build such stations as may be needed within the range of operations to be conducted from each camp. The stations are those used for carrying the azimuth and those used for sounding purposes.

The former are placed as far apart as the

conformation of the coast will allow, so that consecutive azimuth stations are intervisible. The latter are placed from about one-sixteenth to one-fourth of a mile apart, the distance being determined by the character of the bottom, whether there are many rocks and shoals or whether the bottom descends regularly, and near the shore line presents no singularities. Should the topography of the country near the shore line permit, a small system of triangulation is also carried on as a check to other work, and a reconnoissance is always made to test the question as to such a system being practicable. As the plotting of the work is done rectilineal co-ordinates, the axes being the true meridian of the place and the parallel of latitude passing through the place, the work on the field is made so that the computations in reducing the field notes shall be a minimum. Therefore the direction of all lines are taken with reference to the meridian, the only computations being to determine the sides of a right angled triangle having given the two angles and the length of the hypothenuse.

The direction of the true meridian at each camp is found by the method of the greatest elongation of Polaris. The meridian having been determined, a theodolite is placed on the observation post, and the axis of the telescope placed on the meridian, the left hand vernier reading zero and the right-hand 180 deg. (that is, supposing the reading of the horizontal limb of the instrument increases to the left, and the limb graduated from 0 deg. to 360 deg). The lower clamp being then clamped, the upper or limb clamp is loosened, and the telescope is pointed to any station. After reading both verniers the instrument is carried to the station just pointed to, the limb of the instrument remaining clamped, and is set up and pointed on the meridian post, the former right-hand vernier being the left-hand. The telescope being set on the meridian post and clamped, and the upper limb unclamped, if the telescope be turned until the right-hand vernier reads zero, it is evident that the axis of the telescope will be in the meridian, so that to find the angle which any line passing through the station occupied makes with the meredian it is only necessary to keep the upper limb of the instruments clamped at the reading of the foresight to the station occupied, set up the initrument and point it back by means of this lower clamp and tangent screw on the station and meredian post, then unclamp the upper limb and point the instrument in any direction, and the reading of the vernier will be the azimuth of the new direction, and so on from station to station, always taking care that in making foresights the same vernier is on the left-hand.

The checks on the azimuth work are very frequent. Where the shore is concave many stations can be seen from any one station. Now on arriving at any of these stations the instrument, after being set on the immediately preceding station, should be turned back on the farthest station, and the verniers, if the work has been done correctly, should read the same as they did on the foresight from that station when the telescope was directed on the one now occupied. The distances from point to point alongshore are measured by the chain or stadia readings. In cases such as deep bays or rivers, triangulation is resorted to, care always being taken that no angle of a triangle should be less than 30 deg. In starting a system of triangulation a careful measurement of a base is made, and in going off from it the triangles should be as nearly equilateral as possible. Where the extent of surface covered by a system of triangulation is small, a careful measurement with a well-tested chain is considered sufficient; but where the system is to extend for some distance, as along the course of a river, the base is measured with rods on a stretched rope, and as a check bases are measured every 15 or 20 miles along the river.

The topographical survey of the country within one mile of the coast line is made with a theodolite arranged for stadia measurements. This mode of determinining distances and heights is, in a rough country, very much more accurate than careful chaining. An engineer skilled in stadia work can always measure distances within an error of one foot in a thousand. Then, too, this method of surveying is much less expensive than the old way of first running transit lines and following up with the level; for one person, assisted by one rodman and two axemen, can do all the work and more than a transit party and level party. Tables have been prepared by which the horizontal and vertical readings can be at once reduced without much labor. For a complete explanation of this method I would refer those interested to an article written by S. W. Robinson, C. E., formerly an assistant on the Lake Survey. It appears in the February, 1865, number of the "Journal of the Franklin Institute." It would seem that this method might be introduced with great economy on preliminary railroad surveys. This stadia work is connected with the shore-line work at as many points as possible.

The in-shore hydrography is made as follows:

If the shore of a lake is bold and the water deepens rapidly, a line of buoys is placed at the outside limit of the proposed soundings and their locations accurately determined by intersections from shore stations. These buoys are placed nearly opposite the sounding stations and from sounding station to buoys, so that the whole space between the shore line and line of buoys is well covered with soundings. It is generally sufficient to run lines from each station to the five buoys nearest to it. Should the water deepen very gradually, two lines of buoys may be necessary. The soundings are made with a marked lead or graduated pole. They are made without stopping the boat and at intervals marked by the watch. Before the soundings are made a complete scheme of lines is drawn and given to the assistant who has charge of the work, and as each line is sounded it is marked on the sketch, thus showing at a glance what lines remain to be run. The buoy consists of a block of wood turned in a conical form and anchored by a stone attached to it by a rope; a staff with a flag on top of it is inserted in the base of the cone. These flags are so designed of red, white and blue cloths, that each buoy is at once recognized in its order by the arrangement of the colors on its flag. In the survey of a river, sounding stations are located on both banks between which lines of soundings are run.

The direction of a true meridian is determined every ten or twelve miles, and as the different meridians converge a correction for azimuth is necessary and is applied proportionately. All primary triangulation stations, off-shore hydrography and astronomical stations are carefully located by the officer in charge of the party and combined with his work. Having finished a season's work in the field, the party returns for the winter to the office in Detroit, and there makes what are called "detailed charts." In order to plot the work the co-ordinates of every station are first computed and tabulated, together

with the heights above the water's surface, the origin of co-ordinates being any station. Generally, however, the zero is taken at the intersection of the rectangular axis passing through the most easterly (or westerly) and most southerly (or northerly) stations. One of these axes for each sheet is taken parallel to the true meridian on that sheet, and the other axis perpendicular thereto. The scale of these detailed charts is 1-10,000, or about 4 inches to one mile. The topography is represented by horizontal contour lines at intervals of ten feet in height, the zero contour being the delineation of the shore line, forests, fields, etc., being represented by the usual conventional signs. The hydrography is represented by figures showing the depth of water at each point, the character of the bottom being written as rocky, clay, sand, etc.

II.—OFF-SHORE HYDROGRAPHY.

Under this head is included the hydrography of the lake beyond the sounding of the in-shore parties. The work usually is done as follows:

Two observers are placed at stations on shore about six miles apart. A steamer then runs out from the shore in a direction at right angles with general bearing of it. In water under thirty fathoms deep the lead is cast every 7½ minutes (the steamer moving about six to eight miles per hour), the position of the steamer being observed by the shore observers every 15 minutes. The steamer runs out to about twelve miles from the shore for about three-fourths of a mile, and then heads in, sounding at regular intervals. The moment of sounding is indicated by a signal from the steamer, so that the observers on shore have always a means of correcting their time. Should any shoal be found, it is carefully located from shore This is done by setting up, if possible, two stations on the shoal. These stations are located from the shore, and the distance between them computed. The line between these stations is then used as a base from which to locate a sufficient number of buoys. A sextant is used for this latter triangulation for measuring the angles of the buoys. After the buoys are located, the shoal is covered with a network of soundings on lines between buoys and stations. In quiet weather lines of soundings are run from shore to shore of the lakes. The steamer starts from opposite some known point to one shore and steers a course, and the point on which the vessel heads when she sights the opposite shore is also located. The first and last soundings are located by means of double sextant angles taken from steamer to three or more known points on shore. The intermediate soundings are made at equal intervals of time. The deepest soundings in the lakes were taken just north of Copper Harbor, on Lake Superior, where a depth of almost a 1,000 feet was found.

In addition to the above described duties, each steamer is generally charged with the duties of moving and supplying shore and other parties, and all such reconnoissances as may be necessary to properly locate astronomical and triangulation stations. There are three steamers owned by the United States engaged on the survey. Others are chartered. The complement of a steamer consists of 1 assistant in charge, 1 sub-assistant, 2 recorders, 1 master of vessel, 1 mate, 2 enginemen, 4 firemen, 1 carpenter, 2 wheelsmen; 2 leadsmen, 14 seamen, 2 cooks and 1 steward.

The future of our Iron Industry.

Although it has attained such gigantic dimensions, the manufacture of iron in the United States has acquired its importance within the last fifty years, and it may almost be said within the last quarter of a century. Within the last decade its growth has been specially rapid, and also apparently healthy, for the demand has always exceeded the supply to such a degree that our importations have nearly equaled our home production. Until the last year the progress of iron manufacture has been constantly upward and onward. Individuals and communities have been enriched by it; towns and cities without number have grown up under its potent stimulus. All branches of the manufacture have been prosperous, and even all those who dealt in iron, if they manifested ordinary business capacity, were successful beyond those engaged in any other department of commerce. This was the state of things till the autumn of 1873. Then suddenly the whole scene changed. The financial panic arrested the construction of railroads—which have always been the greatest consumers of iron—put a stop to many other enterprises in which iron was largely used, and induced a general paralysis of business, in which the iron trade suffered more than any other. Since then the production of iron has fallen off nearly one-half. A large number of our furnaces have gone out of blast, and others are rapidly following suit. In all our centres of iron production stock has accumulated until it represents a large part of the manufacturer's capital, and no longer serves even as security for borrowed money. In a glutted market sales cannot be effected even at greatly reduced rates, and, as a consequence, universal embarrassment and distress have befallen those who were before the most independent and prosperous of our business men, and tens of thousands of our most useful artizans have been thrown out of employment. Naturally we every where hear these men anxiously asking, When and how is this distress to be alleviated? Can the former prosperity of our iron industry be regained, and if so, how can it be maintained above the chances of such ruinous crises as that we have just experienced? For full and satisfactory answers to these questions more than human wisdom and forecast are required; and yet some rays of light may be made to penetrate the darkness by an intelligent inquiry into the causes of the catastrophe, and an investigation into the possible means of strengthening our iron industry in the future.

As to the causes of the panic, there is probably not much difference of opinion among thoughtful men. A long course of prosperity, and specially the rapid recovery and expansion of business after the war under the stimulus of an inflated currency, had made our people sanguine, rash, intoxicated. Business had become largely speculative in character. Legislation was specially framed to favor banks and railroads. The abundant money of the banks was freely loaned, and furnished an unhealthy stimulus to all branches of business. Railroad building, especially, was overdone. A reaction was inevitable. Sooner or later a day of reckoning *must* come. In short, our people had been on a frolic and must "pay the piper." The railroads were the first to suffer, as they had been the greatest offenders; but in their fall they dragged down every commercial and manufacturing enterprise. The revival of business under such circumstances must necessarily be slow, but it has been greatly retarded by the delay of Congress in adopting a financial policy. It mattered comparatively little *what* policy was adopted, whether of inflation or contraction. Either would have been better than the evils resulting from a continued paralysis of business, and either would have set the wheels of industry in motion again. Until such a policy shall be definitely adopted by Congress, it is hopeless to expect that the great industrial enterprises of the country will resume their activity. Without this they have no solid foundations to rest upon; and such massive structures can not safely, and will not be, founded on shifting sand. In addition to this, confidence must be restored by the substitution, if not of strict honesty, at least of legitimate business enterprise for the speculative and peculative spirit which was recently the order of the day. Human nature makes such reforms slowly and regretfully, and time

will be required for them; but they must come, or there is no health, nor safety, nor future for us as a nation. A better day is, in fact, sure to come. The resources of our country are so great, the vigor and intelligence of our population so marked, and its morality so far inviolate, that its energies and virtues are sure to reassert themselves, health and vigor to be regained, growth to be resumed. A sharp and killing frost is a sad calamity. It mars and scathes all the luxuriance and beauty of nature; but it has its benefits as well, and is at worst a necessary evil. It wilts and destroys all sappy weeds and fungus growths. Yet it leaves the hardy plants, stripped of their foliage maybe, but with their vitality untouched.

In due time natural causes will restore to the business of the country its former activity, and with this we shall see the iron manufacture recover from its present depression. It supplies an indispensable element not only to all progress, but to the maintainance of normal health in every community; even as iron forms an indispensable element in the vital fluid of the individual. But it is to be hoped that its life will be less feverish and its growth be more sound and healthy than heretofore. That this necessity will be laid upon it may be plainly seen. As has been said, the importation of iron to this country has been equal to the home production, and this importation has been burdened with three thousand to four thousand miles of transportation and a heavy duty. These facts prove that iron is made abroad for about half what it costs to make it here. The question whether this difference can be extinguished is one of vast import to our iron industry. Most of the foreign iron used in this country is made in England, but even a cursory examination of the conditions of the iron manufacture there, will show that the materials from which iron is made are less abundant and less excellent than with us. Of both ores and fuels we have at least twenty times the quantity contained in the United Kingdoms, while in quality ours are better and more varied, and they are as conveniently located. How, then, does it happen that the ingenious, enterprising, and energetic Americans are so far outdone by their English relatives? The answer is very simple. The English manufacturer owes his superiority to three things, viz. *cheaper labor*, *greater capital* and *improved processes*. The item of labor in the production of a ton of iron is in this country usually reckoned at about $4, but this refers only to the labor expended upon it at the furnace; in fact, the high price of labor also affects the price of the ore, fuel, flux, and transportation to and from the furnace. This may be safely reckoned at from $4 to $6 more; so that the item of labor in the cost of a ton of iron should really be reckoned at from $8 to $10. In England the price of labor has somewhat enhanced of late, and it cannot be safely reckoned at less than $5 per ton; hence the English manufacturer has an advantage of $3 to $5 per ton in the matter of labor. His greater capital enables him to manage a large establishment with several furnaces by a simple and thoroughly systematized administration and permits him to reap all the advantages of doing business by wholesale and retail, both in buying and selling. His processes are better in this, that he uses larger furnaces, in which the blast has a higher temperature and pressure, and in which the materials are mingled according to reason rather than by the rule of the thumb. Each great iron establishment has its educated expert who brings to the problems before him a thorough understanding of the composition of the materials used, of the changes which take place in the furnace, and also of the lessons taught by experience in other establishments and in other countries. Under his direction the height of the best English furnaces has been carried up one hundred feet, and the weekly product made to reach six hundred tons; and the consumption of fuel has been so far economized that a ton of iron is made with a ton of coke, about half what we use. When, therefore, we shall have acquired the necessary capital, and shall have simply imitated the methods which are the healthy growth of experience abroad and are there in daily regular practice, we shall be able to make iron in all its varieties better and cheaper than it can be done anywhere else in the world, except the only difference in the price of labor. This difference is less than the cost of transportation on English iron to the place where it is used, and is constantly diminishing by the increase of the cost of labor in Europe. So that when we have merely adopted the methods in constant use in the Old World, we can dispense with the tariff and defy foreign competition. Home competition will, however, be in full activity, and to this we must look for the needed reforms. In the present paralysis of business there would seem to be little incentive to such improvements as we have indicated, but the "struggle of life," which has hitherto hardly been felt in the iron manufacture of this country, is destined to be hereafter sharp and bitter. Hitherto, under the stimulus of a constantly expanding market, and under the shield of the tariff, all our iron works, even with small furnaces and rude processes, have done well, and have made their owners rich. Now, only those especially well located and well managed will do this. The others will make little, or lose money, and will be compelled to reduce the costs of their iron by improving their methods. Then the lessons of adversity will not be lost upon our iron manufacturers; and when the present storm has wrought its work and passed, we may expect the iron industries of the country to exhibit a stronger, healthier growth than ever before. Then they will need no protective tariff, but will be self-sustaining, and will produce all the iron consumed in America, even if the demand should increase in the same ratio as during the last happy ten years.—*Prof. J. S. Newberry, in the International Review.*

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The Production of Traffic and Transportation of Freight and Passengers.

A paper by Martin Coryell, C. E., Member of the Society. Read at the Annual Convention held in Louisville, Ky., May 21st and 22d, 1873. Charles Hermany, C. E., in the chair.

Early history and the ruins of ancient civilization attest that Asia and a part of Africa were first densely populated; that agriculture, commerce, and the arts were developed in a high degree, and that the carriage and exchange of products of the soil, materials for building, munitions of war, and the objects of commerce that were necessary to a luxurious people. Among the remains of that age, there is nothing to show the use of modern substitutes for manual labor or beasts of burden, in performing the work of inland transportation.

China and Japan had canals at an early day, and used their rivers similarly for travel and transportation. Greece and Rome employed ships in commerce and for war, constructed canals, opened roads, and erected bridges, the remains of which are still to be seen.

Coming down to modern times, the first canal in France—between the rivers Loire and Seine, 34½ miles long—was begun in 1605, and completed 37 years after; in England, the first—the Bridgewater canal—was begun in 1758. Coaches were introduced about 1605, prohibited in 1635, and in 1770 only 1,000 were registered in the whole kingdom. With coaches, turnpikes, or roads on which tolls were levied, came into use; about 1790, Telford and McAdam began to improve them, and in 1819 Parliament appointed a Committee to examine into their condition.

In this country—soon after the Revolutionary war, as agriculture, manufactures and commerce began to thrive, the people, and particularly those on the seaboard, saw the need of a ready means whereby the products of the soil and the forest could be exchanged for commodities brought over the seas or

made up in town and city. The experience of older countries was consulted, and turnpikes were determined on, not only as meeting a want much felt, but as a profitable investment for surplus funds; charters were therefore granted by the State authority, and soon roads were built, connecting growing cities with fertile agricultural regions or thriving manufacturing centres.

Pennsylvania was the first State to have a regular graded and stoned turnpike, which was chartered in 1792, and finished in two years; it was from Philadelphia to Lancaster, 62 miles long, and cost $465,000, or $7,500 per mile. So beneficial were its effects upon trade and the country through which it passed, that it was extended to Pittsburgh, the most westerly town at that period, 303 miles distant, with ascents not exceeding 3¾ degrees, and passengers were carried in post-coaches from there to Philadelphia in sixty hours. When the road was completed the traffic was not sufficient to pay dividends and for repairs, but in a few years it so increased that double loads were carried in vehicles drawn by four, six, or eight horses, and consequently the tires of the wheels of the "Conestoga wagons" were widened from 1½ to 5 or more inches. The results were that, under the effects of frost, rain, and the heavy traffic, turnpikes became expensive and unprofitable; and the people, in good weather, would travel over a parallel road to avoid paying toll. Soon they were unpopular and condemned by the community generally, and most unjustly; for, until over-burdened by the quantity and weight of traffic, they served well their purpose; thereby cities and towns were built up, the land through which they passed increased in value fivefold, and the general enhancement of taxable property was ten times the original cost of the turnpikes. Now that they are relieved from heavy and ruinous loads, they are if well made and kept, as useful and profitable as in their early career.

Canals were next in this country to relieve commerce, by an exchange of productions, and in their construction New York was first, with that ever-enduring monument of enterprise, the Erie Canal, which was the model, and furnished the engineers and contractors for many others throughout the various States. The history of canals is similar to that of turnpikes; the investments made in them were, in a great measure, lost to the original projectors and owners; generally they were located along rivers, subject to injury by extraordinary freshets, and extended so far towards the river's source that the traffic necessarily done in seven months only of the whole year was made unprofitable by the amount of lockage, scarcity of water, and effects of frost.

When the early canals were completed, their capacity for transportation was so far in advance of the needs of the country, that they largely absorbed the traffic of turnpikes without, for years, earning enough to defray expenses and pay dividends; but as it was with turnpikes, wherever canals were located, manufactures, trade and travel greatly increased, cities and towns were built up, and the adjacent country became prosperous and wealthy consequently, in time the canals were overcrowded with the trade they had reared and were unable to accommodate, and soon, therefore, they too were in degree, condemned and neglected.

The railroad next claimed public attention for the carriage of freight and passengers, and when the locomotive was made its special adjunct by George Stephenson, it took rank and character which led to a success that completely revolutionized transportation and its various interests. Like the turnpike and canal, the railroad in early years was subject to trials of poverty, want of trade and depression of stock, but now it is triumphant, fearing only that the telegraph may take from it the postal and money business of the country as effectually as it did from its slower predecessors.

At first, railroads were only intended for portages between navigable waters; it was generally conceded that they would for many years be all-sufficient when the rivers and lakes of the great West were reached, and it was deemed useless and impracticable to think of proceeding further without transhipment. The productions of the South and West so accumulated that the labor and delay at points of transhipment became a serious cause of waste and cost, which, added to the cost of transportation tended to exclude these commodities from Eastern markets.

The scheme of bridging the Ohio, which floats a vast and increasing commerce in fleets of boats of every style, was violently opposed by the Federal government and the people at large, in Congress and the Courts, to prevent an attempt characterized as chimerical. The history of the Wheeling bridge attests what a grand success it was; it does, and may it ever stand, a pioneer monument of commercial enterprise and engineering skill, proving that traffic by rail need not destroy or greatly obstruct traffic by water. When a few more bridges, as the St. Louis and East River, and a few more tunnels, as the Detroit and Hoosac Mountain, are completed, the chief problems in railroad construction will be solved, and the question "Will it pay?" can be answered.

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Cheap, or as they are commonly termed, "narrow gauge" railroads, with light rails and well-constructed machinery will in time, be substituted for common roads, as feeders and distributers of main lines. In populous manufacturing or in agricultural districts, where the traffic is insufficient for more expensive lines, these may take it at profitable rates until roads of greater capacity are required.

Although railroads and their machinery, as a means of transportation, seem to be nearly perfected, the studies and services of the engineer are not soon to be dispensed with. A brief consideration of subjects now more or less prominent show rather that the field of his labors will in the future be more extended and diversified; a few of these subjects I will mention.

Marsh and swamp lands are to be reclaimed by embankments, ditching and subsoil drainage; rice, cranberries, cotton and other similar crops are to be irrigated; lands are to be cultivated and their products gathered by the aid of steam machinery; forests are to be preserved from the ravages of fire, and extended over barren lands, to keep up and increase the supply of timber, and to equalize the amount of rainfall.

The water in our streams is to be stored up in time of plenty, for domestic and sanitary purposes, to extinguish fires, irrigate lands, furnish power, and to maintain the navigation of canals and rivers. Rivers are to be improved and secured; basins, docks and wharves for shipping, elevators for grain, and warehouses for merchandise are to be constructed. Canals are to be constructed, and abundance of water for increased traffic provided, and the locks extended to take in without delay, at one time, a steam-tug and the boats she may have in tow.

Railroads are to connect the large cities of this continent, located, equipped and operated to maintain a speed of 100 miles per hour with safety and certainty. Superior and intelligent management must reduce the rates of freight so that the products of the soil and the mine, in

regions widely separated, may be exchanged without loss, and at a fair remuneration to the producer.

Safe and permanent buildings, for commercial purposes, with foundations "strong and deep," are to be erected capable of resisting fire, floods, and the severities of our climate, fitted with machinery for hoisting and moving goods or grain, well ventilated and thoroughly adapted to the secure preservation of the property contained, without danger from loss.

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All these things are within the province of the Civil Engineer; but no one man can singly effect their improvement. It is in the aid an end of this Society to include within its membership those who not only can lay foundations under rivers and seas, tunnels beneath lakes and through mountains, span navigable waters, and unite the extremities of a continent, but who, because of their integrity and experience, possess the confidence of those who supply the means, as well as of those who do the work of the undertakings. With such in co-operation, our profession can always perform whatever trade, commerce or the good of our common country may require of it.

The Economical Influence of Science.

The cultivation of science in the fourteenth century gave a wonderful stimulous to inventive talent, directed mainly to useful practical results; and this, subsequently, was greatly encouraged by the system of patents, which secure to the originator a reasonable portion of the benefits of his skill. It is sufficient to refer in the most cursory manner to a few of these improvements; we appreciate at once how much they have done. The introduction of the saw-mill gave wooden floors to houses, banishing those of gypsum, tile or stone; improvements cheapening the manufacture of glass gave windows, making possible the warming of apartments. However, it was not until the sixteenth century that glazing could be well done. The cutting of glass by the diamond was then introduced. The additions of chimneys purified the atmosphere of dwellings, smoky and sooty as the huts of savages; it gave that indescribable blessing of northern homes—a cheerful fireside. Hitherto a hole in the roof for the escape of the smoke, a pit in the midst of the floor to contain the fuel, and to be covered with a lid when the curfew-bell sounded or night came, such had been the cheerless and inadequate means of warming.

Though not without a bitter resistance on the part of the clergy, men began to think that pestilences are not punishments inflicted by God on society for its religious shortcomings, but the physical consequences of filth and wretchedness; that the proper mode of avoiding them is not by praying to the saints, but by insuring personal and municipal cleanliness. In the twelfth century it was found necessary to pave the streets in Paris, the stench in them was so dreadful. At once dysenteries and spotted fever diminished; a sanitary condition, approaching that of the Moorish cities of Spain, which had been paved for centuries, was attained. In that now beautiful metropolis it was forbidden to keep swine, an ordinance resented by the monks of the abbey of St. Anthony, who demanded that the pigs of that saint should go where they chose; the government was obliged to compromise the matter by requiring that bells should be fastened to the animals' neck. King Philip, the son of Louis the Fat, had been killed by a horse stumbling over a sow. Prohibitions were published against throwing slops out of the windows. In 1870 an eye-witness, the author of this book, at the close of the pontifical rule in Rome, found that, in walking the ordure-defiled streets of that city, it was more necessary to inspect the earth than to contemplate the heavens, in order to preserve personal purity. Until the beginning of the seventeenth century, the streets of Berlin were never swept. There was a law that every countryman, who came to market with a cart, should carry back a load of dirt!

Paving was followed by attempts, often of an imperfect kind, at the construction of drains and sewers. It has become obvious to all reflecting men that these were necessary to the preservation of health, not only in towns, but isolated houses. Then followed the lighting of the public thoroughfares. At first houses facing the streets were compelled to have candles or lamps in their windows; next the system that had been followed with so much advantage in Cordova and Granada—of having public lamps—was tried, but this was not brought to perfection until the present century, when lighting by gas was invented.

By the sixteenth century, mechanical inventions and manufacturing improvements were exercising a conspicuous influence on domestic and social life. There were looking-glasses and clocks on the walls, mantels over the fireplaces. Though in many districts the the kitchen-fire was still supplied with turf, the use of coal began to prevail. The table in the dining-room offered new delicacies; commerce was bringing to it foreign products; the coarse drinks of the North were supplanted by the delicate wines of the South. Ice-houses were constructed. The bolting of flour, introduced at the windmills, had given whiter and finer bread. By degrees things that had had been rarities became common—Indian-corn the potato, the turkey, and, conspicuous in the long list, tobacco. Forks, an Italian invention, displaced the filthy use of the fingers. It may be said that the diet of civilized men now underwent a radical change. Tea came from China, coffee from Arabia, the use of sugar from India, and these to no insignificant degree supplanted fermented liquors. Carpets replaced on the floors the layer of straw; in the chambers there appeared better beds, in the wardrobes cleaner and more frequently-changed clothing. In many towns the aqueduct was substituted for the public fountain and the street-pump. Ceilings which in the old days would have been dingy with soot and dirt, were now decorated with ornamental frescoes. Baths were more commonly resorted to; there was less need to use perfumery for the concealment of personal odors. An increasing taste for the innocent pleasures of horticulture was manifested, by the introduction of many foreign flowers in the gardens—the tuberose, the auricula, the crown imperial, the Persian lily, the ranunculus, and African marigolds. In the streets there appeared sedans, then close carriages, and at length hackney-coaches.

Among the dull rustics mechanical improvements forced their way, and gradually attained, in the implements for ploughing, sowing, mowing, reaping, thrashing, the perfection of our times.

It began to be recognized, in spite of the preaching of the mendicant orders, that poverty is the source of crime, the obstruction to knowledge; that the pursuit of riches by commerce is far better than the acquisition of power by war. For, though it may be true, as Montesquieu says, that, while commerce unites nations, it antagonizes individuals, and makes a traffic of morality, it alone can give unity to the world; its dream, its hope, is universal peace.—*Prof. Draper.*